Data plane Enhancement Taxonomy

draft-ietf-detnet-dataplane-taxonomy-01

Jinoo Joung, Xuesong Geng, Shaofu Peng, Toerless Eckert

DetNet 120, July 2024

Summary

- Adopted as WG draft on May 14.
  - draft-ietf-detnet-dataplane-taxonomy-00 was created on May 24.
  - updated to ver. 01 on July 06.
- Updates in 01: Added Reference topologies (RT)

Justification for RTs inclusion

- Comments from 119 meeting (Lou, Shaofu, Toerless)
- To evaluate the data plane solutions how they perform in real networks, in terms of E2E latency bound and jitter bound.
- RT can profoundly impact all the other comments.

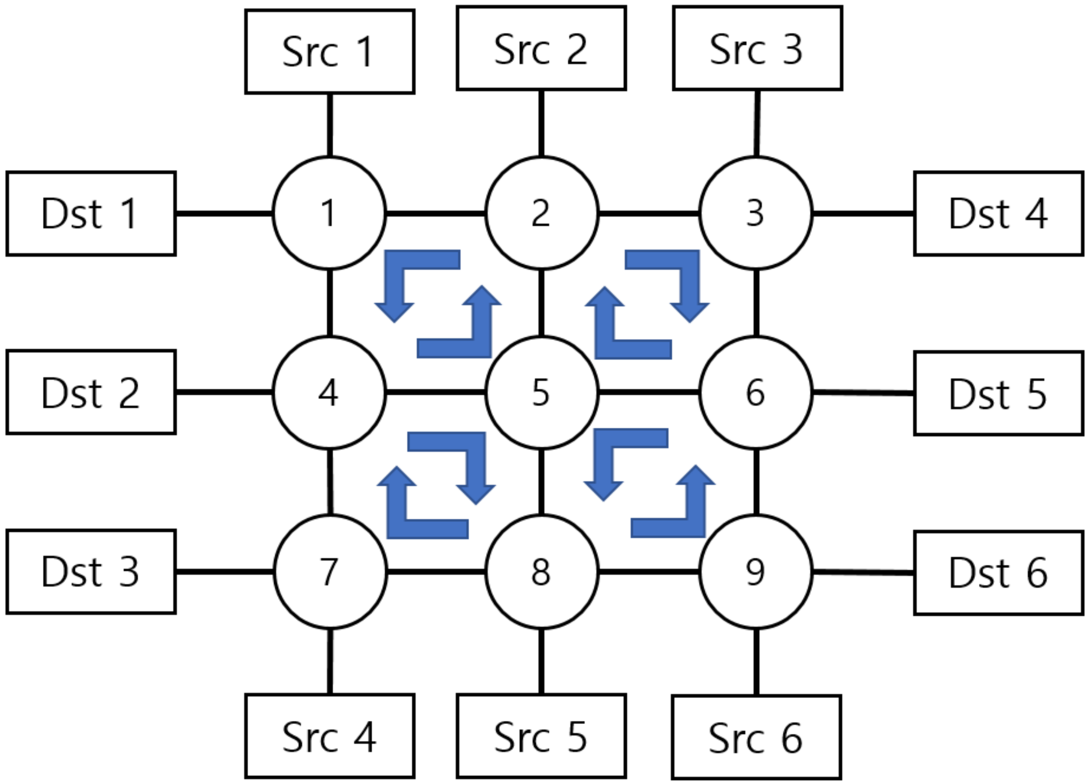
- Note: Unresolved comments from 119 meeting:
  - Inclusion of Antoine's Bounded Queue Delay solution
  - Specifying the buffer space requirements for each solutions (Shaofu, Toerless, Dan Bogdan)
  - Specifying the explicit per-hop or E2E latency, or loss bound for each solutions (Quan)
  - More categorization based on latency, loss, and jitter performance (Quan)
  - Wireless network aspect considerations (Balazs)
  - "Service order" taxonomy is confusing with the current packet reordering mechanism (Lou)

Definition of RT

- An RT consists of 1) a network topology and 2) flows' characteristics.
  1. Network topology specifies the abstract locations of source, destination, relay nodes and their interconnections.
  2. A flow characteristic is composed of its path, requested specifications (RSpec), and traffic specifications (TSpec).
     - RSpec includes the E2E latency and jitter bounds.
     - TSpec includes the maximum burst size and the average rate, as if they have been shaped by a token bucket.
       - Alternatively, a traffic can be specified by the period and the maximum burst size.

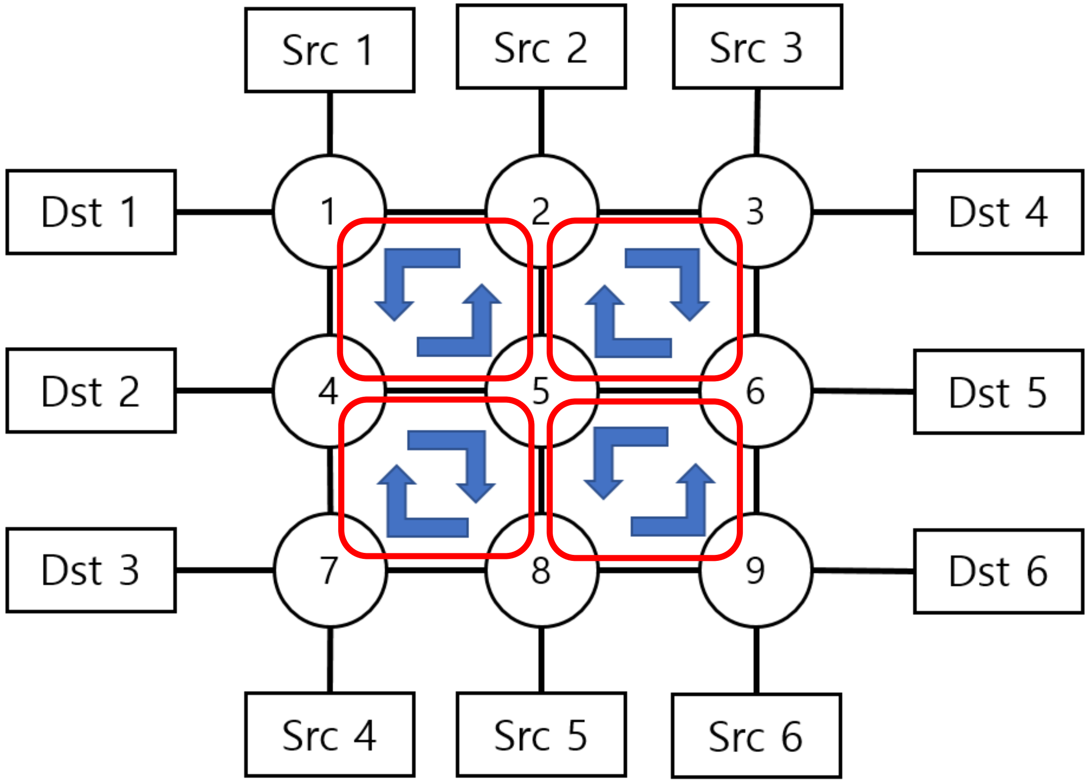
RT: Grid – Network topology

- It represents a general network of partial mesh or grid topology, without considering a specific use case.
- Links are unidirectional. Arrowed links indicate the directions to follow for any traffic route.
- The capacity of all the links in the topology is 1Gbps.



RT: Grid – Network topology justification

- The key components of the topology are the combined cycles.
- These cycles create burst accumulation when a simple scheduler is used, such as FIFO or strict priority (SP) scheduler.
- When highly utilized, FIFO or SP do not guarantee E2E latency bounds in this topology.



RT: Grid – Flow spec

Traffic type	Characteristics
Audio flows	128 or 256byte payload
	1.25ms period
	5 or 10ms deadline
	7/46 proportion
Video flows	ADAS or Vision
	30*1500byte or 15*1500byte frame
	33ms period (30 frame per sec)
	10 or 30ms deadline
	7/46 proportion
Command & Control flows	53~300byte payload
	5 ~ 80ms period
	deadline is equal to the period
	32/46 proportion

Traffic types defined for IVN in [1][2]

- Simplified flow types of in-vehicle networks [3]:
  - Note that they do not have jitter requirements.

Flow type	Maximum burst size	Maximum Packet length	Arrival rate	Required maximum latency
Audio	2Kbit	2Kbit	1.6Mbps	5ms
Video	360Kbit	12Kbit	11Mbps	10ms
Command and Control	2.4Kbit	2.4Kbit	480Kbps	5ms

Table 1: Flow types in in-vehicle networks

Note: Maybe we have over-simplified. C&C flows, which are of our major interest, can have various period and packet sizes.

RT: Grid – Flow spec (cont.)

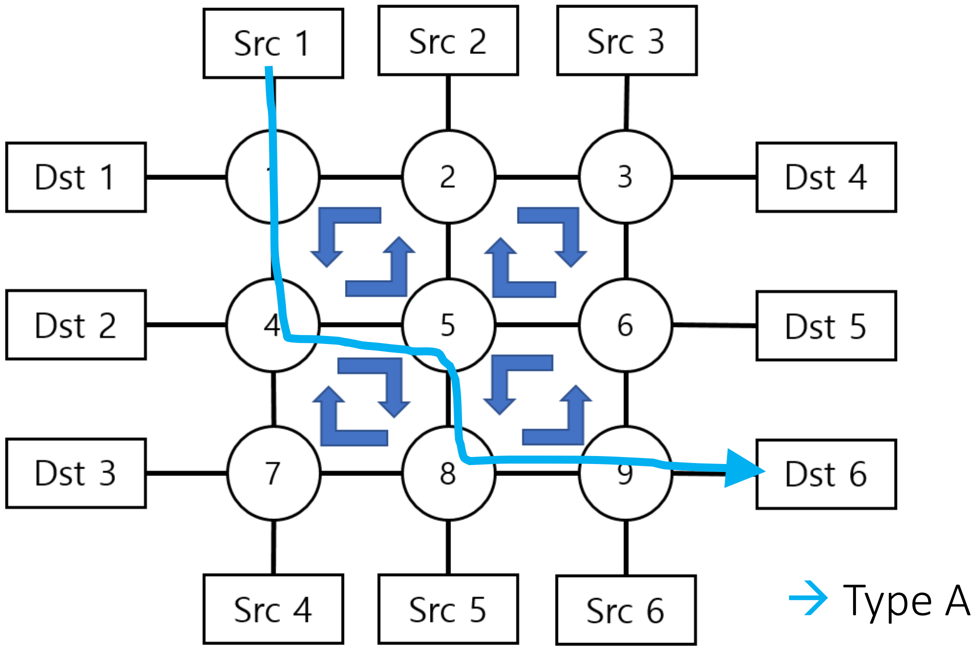
- Flows are aggregated with roughly 1:10 ratio, for simplicity of analysis.

Flow type	Maximum burst size	Maximum Packet length	Arrival rate	Required maximum latency	Destination in Figure 1
A	20Kbit	2Kbit	20Mbps	5ms	Dst 1, Dst 6
B	4000Kbit	10Kbit	100Mbps	10ms	Dst 3, Dst 4
C	20Kbit	2Kbit	5Mbps	5ms	Dst 2, Dst 5

Table 2: Flow type used in the reference topology

RT: Grid – Flow path

- Each source generates a flow to each destination.
  - There are 36 flows overall.
- Each flow type has specific destination nodes.
- For example, type A flows are destined only to destination 1 or 6.



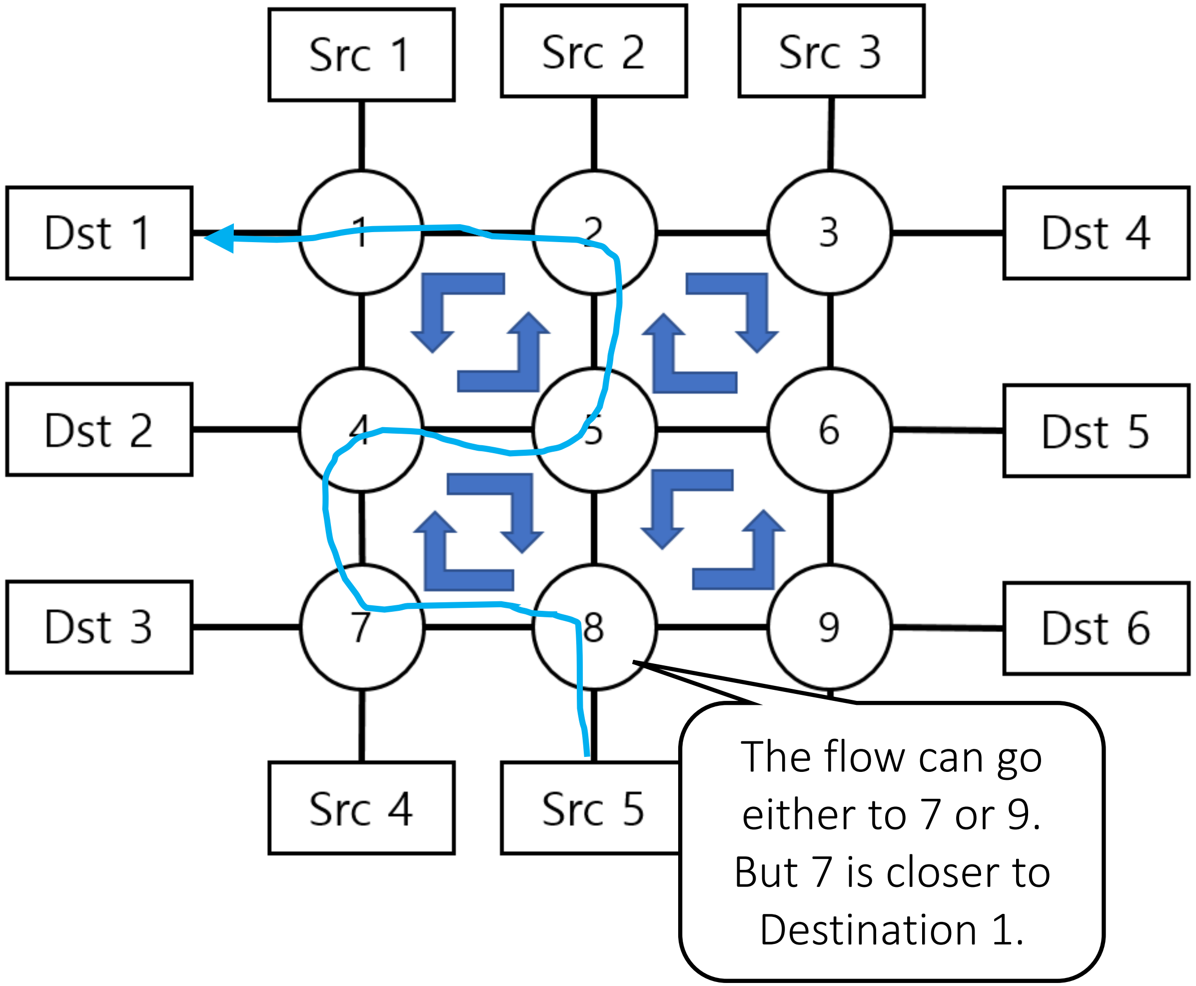
Flow type	Maximum burst size	Maximum Packet length	Arrival rate	Required maximum latency	Destination in Figure 1
A	20Kbit	2Kbit	20Mbps	5ms	Dst 1, Dst 6
B	4000Kbit	10Kbit	100Mbps	10ms	Dst 3, Dst 4
C	20Kbit	2Kbit	5Mbps	5ms	Dst 2, Dst 5

Table 2: Flow type used in the reference topology

RT: Grid – Flow path (cont.)

The rule for flow path decision:

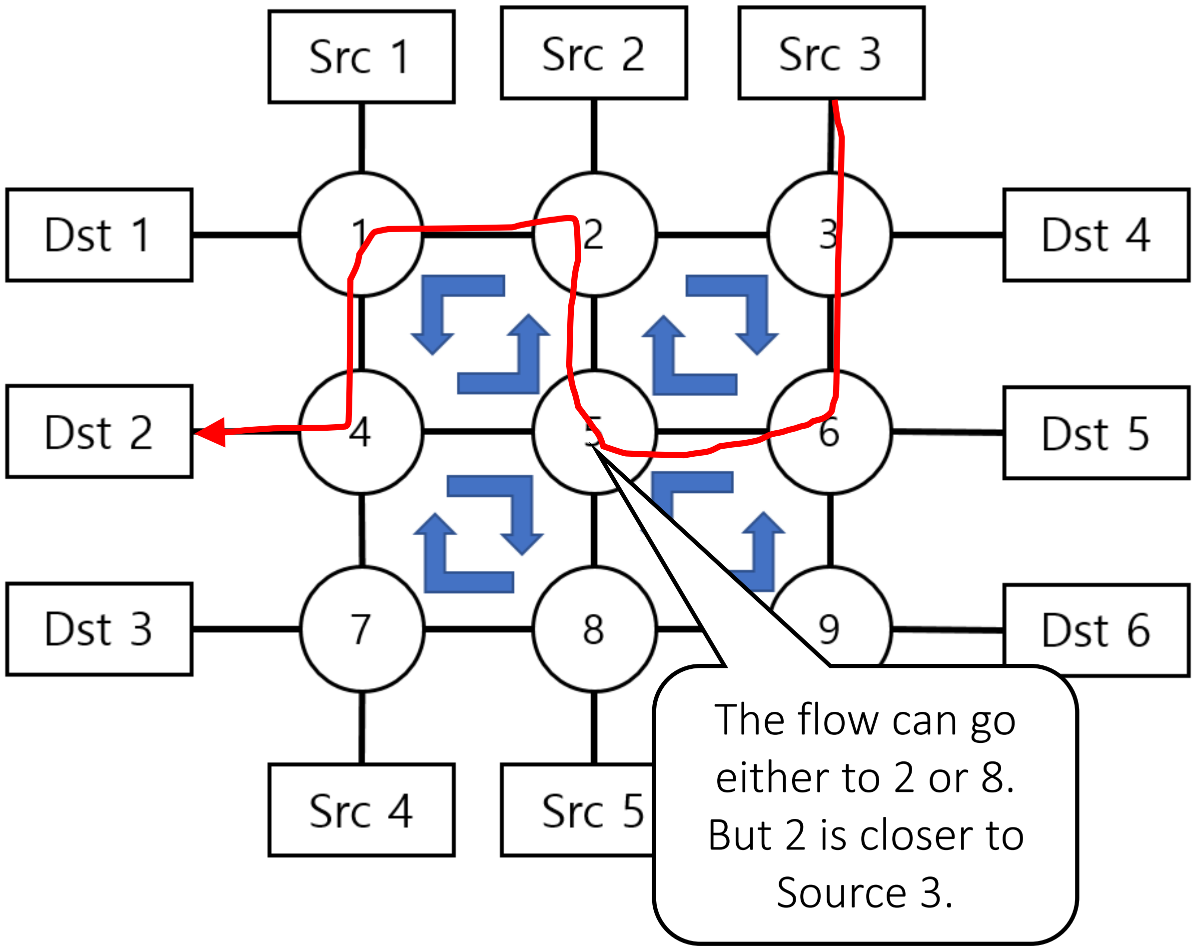
- Shortest path routing
- If there are more than one shortest path,
  - then choose the link that is closer to the destination.



RT: Grid – Flow path (cont.)

The rule for flow path decision.

- Shortest path routing
- If there are more than one shortest path
  - then choose the link that is closer to the destination.
  - If there are still more than one choice
    - then choose the link that is closer to the source.
- This rule gives a unique path (at least in this topology).

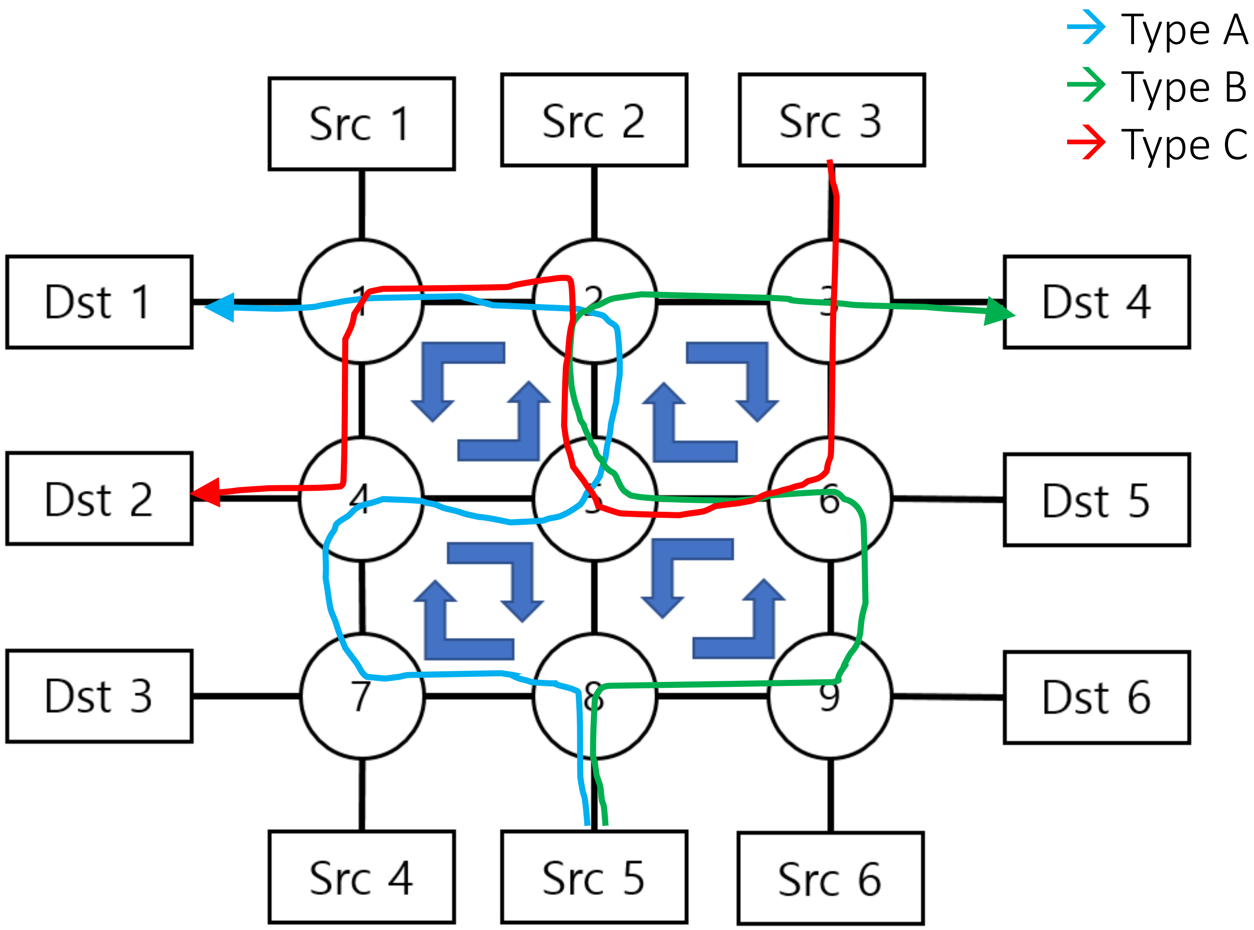


RT: Grid – Flow path (cont.)

- Example maximum hop paths

Flow type	Longest path
A	Src5-8-7-4-5-2-1-Dst1
A	Src2-2-3-6-5-8-9-Dst6
B	Src5-8-9-6-5-2-3-Dst4
B	Src2-2-1-4-5-8-7-Dst3
C	Src3-3-6-5-2-1-4-Dst2
C	Src6-9-6-5-8-7-4-Dst2
C	Src1-1-4-5-2-3-6-Dst5
C	Src4-7-4-5-8-9-6-Dst5

Table 3: Longest path of each flow type in the reference topology

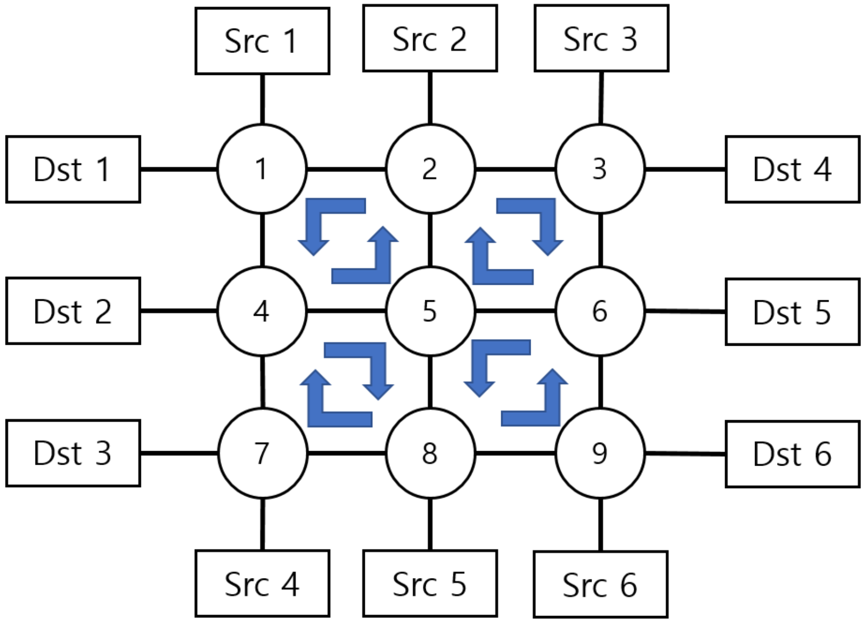


RT: Grid – Utilization

- The bottleneck link is (2,3) and (8,7).
    - There are one type A flow, five type B flows, and two type C flows.
    - Having five very bursty flows in a link is a big burden.
- This sums up to 530Mbps arrival rate on 1Gbps link.
- 53% network utilization

Flow type	Maximum burst size	Maximum Packet length	Arrival rate	Required maximum latency	Destination in Figure 1
A	20Kbit	2Kbit	20Mbps	5ms	Dst 1, Dst 6
B	4000Kbit	10Kbit	100Mbps	10ms	Dst 3, Dst 4
C	20Kbit	2Kbit	5Mbps	5ms	Dst 2, Dst 5

Table 2: Flow type used in the reference topology



Future Plan

- Solicit more RTs
- Fix 2 or 3 RTs
- Evaluate the data plane solutions with RTs
  - E2E latency bound
  - E2E jitter bound
  - Average latency
  - Configuration complexity with dynamic flows join/leave
- Resolve the issues already raised by WG comments

Thank you

- Please take a look at

  https://datatracker.ietf.org/doc/draft-joung-detnet-taxonomy-dataplane/

- Please share your comments and questions.
- References:

[1] J. Migge, J. Villanueva, N. Navet, and M. Boyer. (Jan. 2018). Insights on the performance and configuration of AVB and TSN in automotive Ethernet networks. Embedded Real-Time Software and Systems (ERTS 2018), Toulouse, France. [Online]. Available: https://hal.archives-ouvertes.fr/hal-01746132

[2] N. Navet, J. Villanueva, J. Migge, and M. Boyer, "Experimental assessment of QoS protocols for in-car Ethernet networks," in 2017 IEEE Standards Association (IEEE-SA) Ethernet & IP @ Automotive Technology Day, San-Jose, Ca, Oct. 2017.

[3] Joung, J. and J. Kwon, "Zero jitter for deterministic networks without time-synchronization", IEEE Access, vol. 9, pp. 49398-49414, doi:10.1109/ACCESS.2021.3068515, 2021.